Ontario. Dept. of Highways
General specifications for steel highway bridges, Ontario, 1923

ober, 1923
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PUBLICATION No. 17

GENERAL SPECIFICATIONS

FOR

Steel Highway Bridges

ONTARIO

1923

(Appendix to the Annual Report on Highway Improvement, Ontario, 1923)

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

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PRODUCED BY
The United Press
LIMITED
TORONTO
CANADA

ONTARIO
DEPARTMENT OF PUBLIC HIGHWAYS

Letter of Transmission

TO THE HONOURABLE GEO. S. HENRY,
Minister of Public Works and Highways, Ontario.

SIR,—I have the honour to transmit for your consideration the accompanying revised general specifications for steel highway bridges for publication as an appendix to the annual report of this Department.

These specifications are issued in accordance with the requirements of Section 459 of the *Municipal Act;* and are accompanied by a series of general plans for steel bridges prepared by the Department for the convenience and guidance of municipal authorities.

I have the honour to be,

Sir,

Yours respectfully,

S. L. SQUIRE,
Deputy Minister.

Department of Public Highways, Toronto.

October 15, 1923.

Steel Highway Bridges

The Municipal Amendment Act, Ontario, 1916 (6 George V, Chap. 39) provides as follows:—

Section 459 of *The Municipal Act* is repealed and the following substituted therefor:—

459. (1) Every iron, steel, concrete or stone bridge constructed by the corporation of a county, and every such bridge exceeding twenty feet (20) clear span constructed by the corporation of a township shall be designed and built in accordance with general specifications approved by the Department of Public Highways.

(2) Plans in duplicate for any such bridges may be submitted by the council of any county or township to the Department of Public Highways, and if they are found to be in accordance with such approved general specifications the certificate of the Department shall be attached, and one of such plans shall be returned to the clerk of such county or township.

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GENERAL SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES

Material.

1. The bridge superstructure provided for under these specifications shall be of structural steel, with the following exceptions: Rivets shall be rivet steel, and pins and rollers of high steel. Important castings, such as machinery of movable bridges, shall be of steel, but all cast ornamental work, such as newel posts, may be of iron. The flooring shall preferably be of reinforced concrete, and all bridges shall have wheel guards or curbs so placed as to prevent the hub of any vehicle from striking the railing or any other portion of the bridge. These wheel guards or curbs may be of steel or reinforced concrete.

Types of Bridges.

Design of bridge.

2. The general type of girders and trusses, unless specifically stated, may be determined by the bidder, but shall preferably be:

(1) Rolled beams for spans up to 40 feet.

(2) Riveted low trusses or girders for spans of 40 feet to 90 feet.

(3) Riveted through trusses for spans of 90 feet to 250 feet.

(4) Pin-connected or riveted trusses for spans of 250 feet and upwards. On through spans of 120 feet and upwards, a curved top chord is preferred.

(5) Deck spans shall be used wherever practicable.

(6) Warren trusses will be favourably considered for spans of 40 feet to 90 feet; Pratt trusses for spans of 100 to 250 feet; and Petit trusses for bridges 250 feet in length and upwards.

The foregoing limiting lengths may be varied as directed by the Engineer. The design is in all cases to be such that the stresses in essential members and their connections can be fully determined.

General Dimensions.

Widths and head-room.

3. The general dimensions shall be as elsewhere specified, but in all cases, from the top of the floor to the under side of the portal bracing of through bridges, there shall be a minimum head-room of 14 feet. This head-room to be increased to 16 feet on all main highways. The clear width of the sidewalk should not be less than 6 feet and the clear width of roadway shall preferably be not less than 16 feet, but may be fourteen feet for country bridges not on main highways. The clear width of sidewalks shall mean the distance between the cover plates of end posts and the inside of the hand rail. The clear width of roadway shall mean the distance between cover plates of end posts, or the distance between the inside edges of hand-rails, if such railing projects inside the cover plates of the end posts. The clear width of floor shall be one foot less than the clear width of roadway as defined above, unless otherwise specified by the Engineer.

Assumed Weights of Materials.

Unit weights.

4. Treated or untreated timber shall be assumed to weigh 4½ pounds per foot board measure; sand, gravel or other material used as filling, 100 pounds per cubic foot; paving brick 150 pounds per cubic foot; concrete 150 pounds per cubic foot; steel 490 pounds per cubic foot.

Loading.

Classification.

5. Bridges will be classified according to loading as follows:

Class (A) Bridges suitable for main travelled or county roads.

Class (B) Bridges suitable for roads of light rural traffic and for less permanent requirements.

Class (C) Bridges suitable for heavy traffic on main highways in the vicinity of towns and cities.

Class "A."

Dead load.

6. Each structure shall be designed to carry the following loads:

(1) A dead load consisting of the total weight of metal and other material in the entire suspended structure; provision to be made for steel stringers and a concrete roadway floor at least 6 inches in thickness. Sidewalks, where used, to be assumed to have steel stringers and a concrete floor 4 inches in thickness.

Uniform live load.

(2) A uniform live load covering the whole or any part of the floor for spans 100 feet and under, 100 pounds per square foot of floor space; for spans 200 feet and over, 80 pounds per square foot; for spans of intermediate length, the weight to be reduced uniformly from 100 pounds to 80 pounds per square foot. Floor space considered is to include sidewalks.

Concentrated live load.

(3) A concentrated live load of 15 tons passing over any portion of the floor, on two axles at 10 feet centres and 6 feet gauge, two-thirds of the load to be carried on rear axle. When stringers are not more than 3 feet apart centre to centre, and when a reinforced concrete floor is used, one-half of the concentrated wheel load shall be considered as supported by one stringer. For wider spacing of stringers the wheel load considered on each stringer shall be increased in the ratio that such greater spacing bears to 3 feet.

Floor slab load.

(4) For reinforced concrete bridge floors, a concentrated load of 3,000 pounds midway between stringers or beams and resting on a base one foot square and assumed as supported by a transverse strip of slab one foot wide.

Wind stresses.

(5) All truss spans shall be designed for a lateral force on the loaded chord of 300 pounds per lineal foot and 150 pounds per lineal foot on the unloaded chord. These forces shall be considered as moving.

Truss members.

(6) In Class "A," "B," and "C" bridges, stresses in truss members and tower legs from assumed wind forces need not be considered except to provide:

(*a*) That the wind stresses on any member shall not exceed by more than 25 per cent. the maximum fixed for dead and live loads.

(*b*) That the wind stress alone, or combined with a possible temperature stress, shall not neutralize or reverse the stresses in any member.

Class "B."

7. Each structure shall be designed to carry the following loads:

Dead load.

(1) A dead load as stated under Class "A."

Uniform live load.

(2) A uniform live load considered as covering the whole or any part of the floor, for spans 100 feet and under, 80 pounds per square foot of floor space; for spans 200 feet and over, 50 pounds per square

foot; for spans of intermediate length, the load to be reduced uniformly from 80 pounds to 50 pounds per square foot. Floor space considered is to include sidewalks.

(3) A concentrated live load of 10 tons passing over any portion of the floor on two axles at 10 feet centres and 6 feet gauge, two-thirds of the load to be carried on rear axle. When stringers are not more than 3 feet apart centre to centre, and when a reinforced concrete floor is used, one-half of the concentrated wheel load shall be considered as supported by one stringer. For wider spacing of stringers the wheel load considered on each stringer shall be increased in the ratio that such greater spacing bears to 3 feet. Concentrated live load.

(4) For reinforced concrete bridge floors, a concentrated load of 3,000 pounds applied and supported as stated under Class "A." Floor slabs.

(5) Wind forces as stated under Class "A." Wind forces.

Class "C."

8. Each structure shall be designed to carry the following loads:

(1) A dead load as stated under Class "A." Dead load.

(2) A uniform live load similar to Class "A," except that for spans up to 30 feet the loading shall be 135 pounds per square foot, to be reduced proportionally to 100 pounds for spans up to 100 feet in length, the loading on sidewalks for all spans to be 100 pounds per square foot. Uniform live load.

(3) A concentrated live load of 20 tons passing over any portion of the floor on two axles at 10 feet centres and 6 feet gauge, two-thirds of the load to be carried on rear axle. When stringers are not more than 3 feet apart, centre to centre, and when a reinforced concrete floor is used, one-half of the concentrated wheel load shall be considered as supported by one stringer. For wider spacing of stringers the wheel load considered on each stringer shall be increased in the ratio that such greater spacing bears to 3 feet. Concentrated live load.

(4) For reinforced concrete bridge floors, a concentrated load of 4,000 pounds applied and supported as stated under Class "A." Floor slabs.

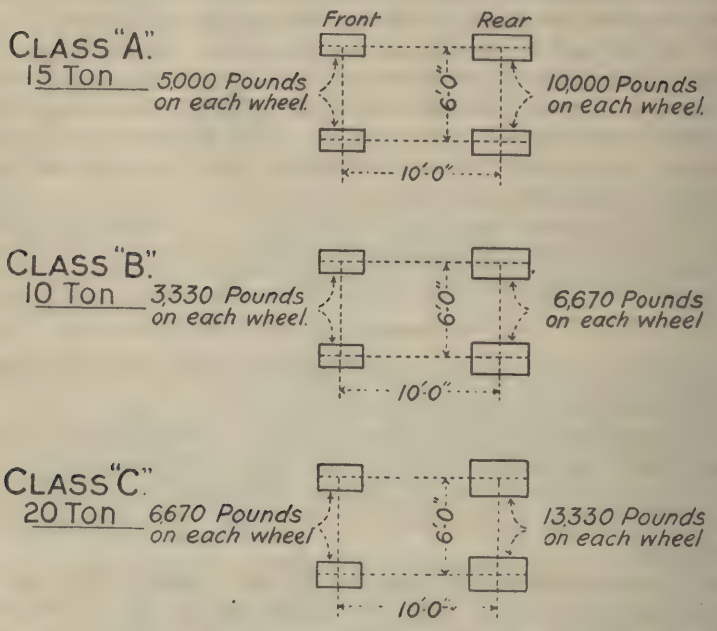
(5) Wind forces as stated under Class "A." Wind forces.

9. Trestle towers shall be designed for a force of 50 pounds per square foot on one and one-half times the vertical projection of the structure.

10. For pin connected trusses the effective length shall be the distance between centres of end pins of trusses. For riveted trusses and girders it shall be the distance between centres of bearing plates. For stringers it shall be the distance between centres of floor beams. For floor beams it shall be the perpendicular distance between central planes of trusses. For columns, posts and chords it shall be the distance between the intersection of gravity lines of the members. These effective lengths are to be used in calculating moments, stresses and working strengths. Effective length for calculation.

11. Effective depth for pin connected trusses shall be the perpendicular distance between gravity lines of chords; for plate girders and open web riveted girders, the perpendicular distance between centre lines of gravity of upper and lower flanges, but never to exceed the depth from out to out of flange angles. Effective depths for calculation.

Diagram of Concentrated Live Loads.



Allowable Unit Stresses.

Stresses.

12. All parts of the structure shall be so proportioned that the following unit stresses in pounds per square inch shall not be exceeded:

Tension.

(1) Axial tension on net section..... 16,000

Compression.

(2) Axial compression on gross section..... $16{,}000 - 70\frac{l}{r}$

In which "l" is the length of member in inches, and "r" is the least radius of gyration in inches.

(3) Direct compression on steel castings..... 16,000

Bending.

(4) Bending on extreme fibres of rolled shapes, built sections, girders and steel castings (net section) 16,000

Extreme fibres of pins..... 24,000

Shearing.

(5) Shearing:

Shop-driven rivets..... 10,000

Field-driven rivets..... 8,000

Plate girder webs (gross section)..... 10,000

Pins..... 12,000

Bearing.

(6) Bearing:

Shop-driven rivets..... 20,000

Field-driven rivets..... 16,000

Pins..... 24,000

Rollers.

(7) Steel expansion rollers, per lineal inch..... 600d

In which "d" is the diameter in inches.

Timber.

Stresses.

(8) The allowable working stresses in bending on the extreme fibres of timber shall be as follows, all stresses being given in pounds per square inch:

Douglas fir or Long Leaf Southern yellow pine	1,800
White oak	1,600
Red or white pine	1,200
White spruce	1,000
Tamarac	1,000
Hemlock	800

Masonry.

Bearing on masonry.

13. Bearing under bed plates, in pounds per square inch, shall be as follows:

Stone or gravel concrete	500
Granite masonry, best ashlar	500
Sandstone or limestone masonry, best ashlar	400

Impact.

Percentage for stringers, floor beams, hangers and trusses.

14. Impact shall be added to the maximum computed live load stresses. For stringers, floor beams and hangers the impact shall be 30 per cent. of the maximum computed live load stress, and for all other members, except as noted below, the impact to be added shall be 10 per cent. of the maximum computed live load stress.

Wind forces.

15. Impact shall not be added to stresses produced by lateral or wind forces.

Impact on counters.

16. For counters and members having alternate live load stresses of tension and compression the impact to be added shall be 50 per cent. of the greater live load stress. For members having alternate live load stresses of tension and compression the impact shall be considered as either tension or compression and shall be added to the algebraic sum of the dead load stress and the live load tension stress or the dead load stress and the live load compression stress. Where the live load stress of opposite sign from the dead load stress exceeds 50 per cent. of the dead load stress, members shall be capable of resisting either combination.

General Design.

Angles fastened by both legs.

17. Angles subject to direct tension must be fastened by both legs, otherwise the section of one leg only is to be considered effective.

Combined stress.

18. A member subjected to axial and transverse stresses shall be so proportioned that the greatest fibre stress shall not exceed the allowable unit stress for tension or compression. In members continuous over panel points, only three-fourths of the transverse stress, computed as for simple beams shall be added to the axial stress. The bending moment at the panel points shall be assumed equal to that at the centre but opposite in character.

Spacing of trusses.

19. The width between centres of trusses shall in no case be less than one-twentieth of the span between centres of bearings, nor less than is necessary to prevent an uplift under the assumed lateral loading.

Length of compression members.

20. The length of a compression member shall not exceed 100 times its least radius of gyration for main members, nor 120 times for laterals, struts and wind bracing.

Flanges.

21. Compression flanges of beams and girders shall be of the same gross section as the tension flanges.

Rolled beams.

22. Rolled beams shall be proportioned by their moments of inertia.

Net section.

23. The effective diameter of a driven rivet will be assumed the same as its diameter before driving. In deducting the rivet holes to obtain net section in tension members the diameter of the rivet holes will be assumed as one-eighth inch larger than the undriven rivet. There shall be deducted from each member as many rivets as there are gauge lines, unless the distance centre to centre of rivets measured in the diagonal direction is 40 per cent. greater than their distance centre to centre of gauge lines. The reduction of stress towards the end of a member due to the transmission of stress from member to connecting plates may be considered.

Rupture.

24. Design, material and construction throughout shall be such that rupture will occur in the body of members rather than in any of their details or connections.

General Construction.

Workmanship.

25. All parts forming a structure shall be built in accordance with approved drawings. Workmanship and finish throughout shall be first-class and equal to the best practice in modern bridge works.

Twists and bends.

26. All material shall be straightened in the shop before being laid off or worked in any way, by methods which will not injure it. Members, and the several pieces when formed into one member, shall be straight and free from twists or bends. Any material damaged in transit must be rejected when such damage consists of sharp kinks. Only slow bends may be rectified in the field, but in no case is the member to be heated for this purpose. The straightening of a built member will not be permitted after it has been riveted together.

Open construction.

27. All parts of the structure shall be accessible for cleaning, painting and inspection.

Camber.

28. All truss bridges are to be cambered by making each panel of the upper chord longer than the lower chord in the proportion of 3-16 inch in 10 feet for short spans, and 1-8 inch for 10 feet for long spans.

Joints to be fully spliced.

29. Joints in riveted work, whether in tension or compression, shall be fully and symmetrically spliced. Compression members shall be connected at the abutting ends by splices sufficiently strong to hold them in true position, and for their full strength except in the case of intermediate box chord and tower column splices, when the abutting ends may be considered to transfer 20 per cent. of the stress in the member.

Abutting joints.

30. Abutting joints shall be cut or dressed true and straight and fitted close together. In compression joints, depending on contact bearing, the surfaces shall be truly faced, so as to have even bearings after they are riveted up complete and when perfectly aligned.

Assembling.

31. Riveted members shall have all parts well pinned up and firmly drawn together with bolts before riveting is commenced. Surfaces in contact shall be painted and allowed to dry before being riveted together.

Screw ends.

32. Bars having screw ends, where their use is expressly permitted by the Engineer, shall be upset so that the minimum diameter through the threaded portion shall be 10 per cent. greater than any part of the body of the bar. The smallest section of any bar shall be one inch diameter for round bars, and $\frac{7}{8}$ inch for square bars.

Welding steel.

33. No reliance will be placed on the welding of steel.

Shearing.

34. Shearing shall be neatly and accurately done, and all parts of the work exposed to view neatly finished.

Care in transportation.

35. The material for the bridge in all stages of transportation, handling, and piling is to be kept clean, and injury from breaking, bending or distortion prevented.

Forked ends.

36. Ends of compression members forked to connect to the pins are to be avoided, if possible, but if permitted by the Engineer they must have pin plates sufficient to make the jaws twice the sectional area of the member. At least one of these plates shall extend to the far edge of the farthest tie plate and the balance not less than 6 inches beyond the near edge of the same plate.

Eccentricity.

37. Eccentricity shall be avoided in all parts of the structure.

Batten plates and lattice.

38. The open sides of compression members shall be stayed by batten plates at the ends, and diagonal lattice-work at intermediate points. Batten plates shall be placed as near the ends as practicable and shall have a length not less than the greatest width of the member or $1\frac{1}{2}$ times its depth, except that in riveted trusses where 6 inch, 7 inch or 8 inch channels are used, the batten plates may be 10 inches in length and for 9 inch channels they may be 12 inches in length. Tension members may be stayed by batten plates or latticed.

Compression members.

39. The material in compression members must be concentrated principally at the sides in flanges and vertical webs. Cover plates shall have a thickness not less than one-fortieth (1/40) of the distance between rivet lines. The thickness of each web shall be not less than one-thirtieth (1/30) of the distance between its connections to the flanges.

Upper chords and end posts.

40. Upper chords and end posts of through trusses shall preferably be of box section. In box chords with built up webs sufficient metal is to be concentrated at the bottom in order that the centre of gravity will be near the centre of the web-plates.

End members of through trusses.

41. End vertical suspenders, and two end panels of the lower chord shall be rigid members if expressly required by the Engineer.

Double members of lattice trusses.

42. Members shall be double, and have symmetrical connections. Plates or flats alone are not to be used for tension members.

Water-proofing.

43. Spaces where water can collect are to be drained. A cover plate shall preferably extend over the top of gusset plates at the shoe to prevent the collection of debris and water between the plates. All stiffeners, fillers, splice-plates and riveted connections are to fit sufficiently close to prevent, when painted, the admission of water. An expansion apron for the expansion end of all truss spans shall be supplied.

Minimum thickness.

44. The minimum thickness of material shall be 5/16 inch except lattice bars and fillers. Where specifically required by the Engineer

the minimum thickness for large and important structures shall be ⅜ inch. The webs of channels may be of thickness approved by the Engineer, but minimum weights per foot shall be: For 5-inch channels, 9 pounds; 6-inch channels, 10½ pounds; 7-inch channels, 12¼ pounds; 8-inch channels, 13¾ pounds; 9-inch channels, 15 pounds; 10-inch channels, 20 pounds; 12-inch channels, 20½ pounds; 15-inch channels, 33 pounds. The minimum angle shall be 2½ inch x 2½ inch x 5/16 inch, or 3 inch x 2 inch x 5/16 inch, except the bottom angles of handrails, which may be 2½ inch x 2 inch x ¼ inch. No I-beam smaller than 9 inches shall be used except for Class B bridges or where expressly permitted by the Engineer.

Rivets.

Diameter.

45. Rivets shall generally be ¾ inch or ⅞ inch in diameter, smaller ones being employed for angles less than 3 inches wide and channels less than 8 inches deep. Rivets ⅝ inch in diameter may be used in the flanges of beams 6 inches and 7 inches deep and ¾-inch rivets in the flanges of beams greater than 8 inches in depth. Rivets ⅞ inch in diameter may be used in the flanges of beams 18 inches deep and over.

Edge distance.

46. The minimum distance from the centre of any rivet hole to an edge shall be 1½ inches for ⅞-inch rivets; 1¼ inches for ¾-inch rivets and 1⅛ inches for ⅝-inch rivets except the rolled edges of shapes, where the edge distance will be as great as the shape will permit. The maximum distance from the edge shall be eight times the thickness of the plate but shall not exceed 3 inches.

Grip.

47. No rivet shall have a longer grip than five times its diameter.

48. All holes must be clean cuts without torn or ragged edges.

Laying off rivet holes.

49. Rivet holes shall be accurately laid off and punched in such a manner that, when the several pieces forming a member are bolted up, the holes will match accurately.

Drifting.

50. Drifting will not be allowed. Holes not matching must be reamed.

Punching holes.

51. Rivet holes may be punched full size unless sub-punching and reaming is specified. When rivet holes are punched full size the diameter of the punch shall not be more than 1/16 inch greater than the diameter of the rivet, nor the diameter of the die more than ⅛ inch greater than the diameter of the punch. When the hole is sub-punched the punch shall have a diameter not less than 3/16 inch smaller than the nominal size of the rivet and it shall be reamed to a diameter not more than 1/16 inch larger than the nomina diameter of the rivet. The holes before reaming must be matched so that at least 1/16 inch is removed from the die side of the holes. The reaming shall be done with twist drills and without any lubricant.

Burrs.

52. The outside burrs on reamed holes shall be removed.

Driving.

53. Shop and field rivets must be power driven wherever practicable. Field riveting must be reduced to a minimum. Hand driven rivets will not be allowed in the case of rivets exceeding ⅞ inch in diameter.

Loose rivets.

54. Rivets must completely fill the holes, and no burned, loose or badly formed rivets will be allowed nor any recupping or calking. They must have full round heads concentric over the shank of the

rivet; be of a height not less than 6/10 the diameter of the rivet; be in full contact with the surface and grip the assembled pieces firmly.

55. Rivets must be uniformly heated to a light cherry red heat. Under no circumstances shall rivets be driven with points hotter than heads. Heating rivets.

56. In cutting out rejected rivets, the adjacent material must not be injured; if necessary the rivets shall be drilled out. Cutting out rivets.

57. Rivets shall in general not be used in direct tension. Should their use in direct tension be in any case permitted, their value shall be estimated by using a unit stress of 2-3 of the unit stress for material in tension as previously given. Rivets in direct tension.

58. The pitch of rivets in any class of work is not to be less than three diameters of the rivet; but shall be 2½ inches for ¾ inch rivets and 3 inches for ⅞ inch rivets; nor shall the pitch exceed 6 inches or 16 times the thickness of the thinnest outside plate. In angles with two rows of rivets staggered, the maximum pitch may be twice the foregoing in each row. At the ends of compression members, for a length equal to twice the width of the member, the pitch of rivets shall not exceed four diameters of the rivets. Pitch of rivets.

59. The distance between rivet lines in plates subject to compression shall not exceed thirty times their thickness; except cover plates of top chords and end posts, in which the unsupported width shall preferably not exceed 40 times their thickness, but where a greater width is used for chords and posts, only 40 times the thickness shall be considered as effective section. Rivet lines.

60. Where two or more plates are used in contact, they shall be held closely together by rivets not more than 12 inches apart in either direction. Plates in contact.

61. Holes for floor beam and stringer connections shall be sub-punched and reamed to an approved steel templet. All other field connections except those for lateral and sway bracing shall be assembled in the shop and the unfair holes reamed and when so reamed the pieces shall be match marked before being taken apart. Floor beam and stringer connections. Reaming field holes.

62. Holes in tension flanges of beams shall be drilled in the middle half of the beam, and other holes in flanges or in webs may be punched. Holes in tension flanges.

Rolled I-Beam Spans.

63. Rolled I-beams shall have a depth of not less than 1/20 of the span. Depth.

64. Outside girders of rolled beam spans shall have sole-plates riveted to the flanges and bolted through bed plates to the masonry at one end and free to slide longitudinally at the other. Girder spans shall have rigid cross struts at their ends. Beam spans shall have rigid cross struts at their ends and also at the centre. Sole plates and cross struts.

Floor Beams and Stringers.

65. Stringers shall be of steel, spaced not more than 3½ feet centre to centre. Spacing.

66. Stringers shall preferably be riveted to the webs of floor beams, but if resting on the floor beams they shall have a full and even bearing and be securely riveted to them with not less than two rivets at each end of stringer. Attaching stringers.

Square ends.

67. The ends of floor beams and stringers shall be cut true and square.

Connection angles.

68. Connection angles for floor beams and stringers must not be less than $\frac{3}{8}$ inch in thickness; they shall be set true and square, flush with each other and correct as to position and length of girder. Where milling is expressly required by the Engineer, connection angles 7/16 inch thick shall be used; they shall be true and correct in position but the necessity for milling more than 1/16 inch from their thickness will be cause for rejection.

Position of floor beams in pin and riveted bridges.

End floor beams provided.

69. Floor beams in bridges with pin connected chords shall be riveted to the post preferably above the pins; if located below the pins the post shall be extended down to provide rigid connection. In deck bridges the floor beams shall preferably be riveted to the posts below the top chord. Floor beams shall preferably be square to the trusses or girders. End floor beams shall preferably be provided on girder spans and trusses.

Stringers bearing on masonry.

70. Stringers resting on masonry shall have full and even bearing thereon.

Floor beam to be stayed.

71. Floor beams shall be effectively stayed against end motion or tendency to rotate from action of the lateral system.

Hangers.

72. The use of floor beam hangers will be avoided where possible. When used they shall be rigidly attached to the trusses, and so arranged as to stay the floor beams against rotation or end motion.

Diaphragms.

73. Diaphragms shall be provided at all floor beam connections.

Lattice Bars.

Width and thickness.

74. The width of lattice bars shall be about three times the diameter of connecting rivets. The minimum width of lattice bars shall be $1\frac{1}{2}$ inches for members 6 inches wide; $1\frac{3}{4}$ inches for members 9 inches wide; 2 inches for members 12 inches wide; $2\frac{1}{4}$ inches for members 15 inches wide; and $2\frac{1}{2}$ inches for members 18 inches or more in width. Subject to a minimum thickness of $\frac{1}{4}$ inch, except for hand-rails, the thickness of single lattice bars shall not be less than 1/40 of the distance between the rivets connecting them to the members, and double lattice bars connected by a rivet at the intersection, not less than 1/60 of the distance.

Angle of bars.

75. Single lattice bars shall make an angle of not less than 60 degrees with the axis of the members, and double lattice bars with riveted connections, an angle of not less than 45 degrees.

Double lattice.

76. Double lattice shall be used on all members having a clear width between webs of 20 inches or more, the bars to be connected by a rivet at the intersection.

Spacing.

77. Lattice bars shall be so spaced that the portion of the flange between their connections shall be as strong as the member as a whole. The pitch of lattice bars must not exceed the width of the channel plus 9 inches.

Rounded ends.

78. Lattice bars shall have neatly rounded ends unless otherwise called for.

Bed Plates, Shoes and Expansion.

Pedestals. 79. Pedestals must be of approved design and must properly distribute the loads over the bearings or rollers. Bearing surfaces of bed plates and vertical webs shall be planed true and smooth. Cast bed plates shall be planed top and bottom. The finishing cut of the planing tool shall be fine and correspond with the direction of expansion.

Bed-plates. 80. Under pedestals at both ends there must be bed plates or bearings of an approved form, of sufficient thickness to distribute the weight properly on the masonry; the minimum thickness for trusses to be $\frac{7}{8}$ inch and for outside girders of beam spans $\frac{3}{4}$ inch. Sheet lead at least $\frac{1}{4}$-inch thick is to be placed under bed-plates if required by the Engineer.

Anchor bolting bed-plates. 81. Bed plates and bearings of trusses and girders shall be fox-bolted to the masonry; bolts for trusses to be not less than $1\frac{1}{4}$ inches diameter, and for girders or beams not less than $\frac{7}{8}$ inch diameter, and to extend not less than 12 inches into the masonry. The Contractor must drill all holes, furnish fox-bolts, and set to place with Portland cement grout.

Sliding plates. 82. Bridges of 80 feet span or less shall be secured at one end to the masonry, and the other shall be free to move longitudinally on smooth surfaces.

Expansion rollers. 83. Bridges exceeding 80 feet span shall have at one end a nest of expansion rollers bearing on planed surfaces. On towers, sliding plates of hard bronze or other non-corrosive material are to be used.

Expansion. 84. Provision shall be made for variation from change of temperature to the amount of $\frac{1}{8}$ inch in 10 feet. Slotted holes must be provided in sliding plates long enough to prevent any possible shearing of the anchor bolts. If specially required by the Engineer the slotted holes shal be covered by plate washers and be large enough to take a piece of pipe around the bolt to screw against so that the washer will not bind on the sliding plate.

Expansion joints. 85. Single span bridges shall have a steel expansion apron at the expansion end of the floor and a $\frac{3}{4}$ inch vertical tar, pitch or fibre bitumen joint between the floor and ballast wall at the fixed end. Bridges composed of two or more spans shall have expansion aprons and expansion joints as directed by the Engineer.

Design of rollers and bearings. 86. The motion of the rollers shall be efficiently guided, and construction shall, as far as possible, be such that the entrance of dirt will be prevented; that rollers and bearings will not retain water, and that they may be readily cleaned.

Size of rollers. 87. Rollers less than 3 inches in diameter must not be used for spans under 150 feet long, nor rollers less than 4 inches in diameter for longer spans.

Material. 88. Rollers must be turned, of cold rolled, high or machinery steel.

Bearings for two spans. 89. Where ends of two spans rest on the one pier or abutment, a continuous bed plate, not less than $\frac{1}{2}$ inch thick, shall extend under the two adjacent bearings; otherwise the two bearings must be rigidly fastened together.

Side motion. 90. Expansion ends shall be firmly fixed against lifting or side motion.

Eye Bars.

Up-setting and forging.

91. The heads and necks of eye-bars shall be of such dimensions as will develop the full strength of the bar. They shall be formed by upsetting or forging. Welding will not be allowed. Bars must be annealed after forging.

Boring pin holes.

92. The bars must be straight before boring, the pin-holes to be in the centre of the head and on the centre line of the bar. An error in diameter of pin-hole or calculated length of bar exceeding 1/32 inch will be cause for rejection.

Bars in same panel.

93. Bars to be placed side by side in the same panel shall be bored in such manner that, when laid on top of one another, the pins will pass through the holes at both ends without driving. The bars of a set shall be laid symmetrically around the centre of pin and shall be as nearly parallel as possible, the maximum allowable inclination being limited to one inch in 16 feet.

Pins and Pin Holes.

Length and attachment.

94. Pins are to be of sufficient length to give a full bearing for their connections. They shall be secured by solid nuts and washers, or by standard hexagonal recessed nuts which shall be turned home to full bearing. The screw ends shall be of sufficient length to burr the threads.

Blooms.

95. Pins over 7 inches in diameter must be forged.

Fitting pin holes.

96. Lateral pins, and pins of 6 inches diameter and upwards, shall fit the pin holes within 1/32 inch, and pins of less diameter within 1/50 inch.

Effective section.

97. Riveted tension members, with pin-hole connections, must have, through the pin holes, an effective section 25 per cent. greater than the net section area of the member, and the net section area back of the pin hole, parallel with the axis of the member, shall not be less than the net section of the body of the member.

Pin holes to be reinforced.

98. Pin holes shall be reinforced by plates where necessary and at least one plate shall be as wide as the flanges will allow and be on the same side as the angles. They shall contain sufficient rivets to distribute their portion of the pin pressure to the full cross section of the member.

Turning and driving.

99. Pins and rollers shall be accurately turned to gauges, shall be smooth and straight and entirely free from flaws. Pins shall be driven to place with a pilot nut.

Vacant spaces.

100. The several members attached to the pin shall be so packed as to cause the least bending moment upon the pin, all vacant spaces to be filled with filling rings so as to hold the member against lateral displacement.

Pin holes.

101. Pin holes shall be bored true to gauges, smooth and straight, and must be exactly perpendicular to the plane of the truss. The boring shall be done after the member is riveted up.

Bolts.

Bolts.

102. Bolts, when their use is expressly permitted by the Engineer, must be of neat lengths; must have hexagonal heads and nuts, and

when in contact with wood shall have a washer under the heads and nuts. Holes in members to be connected by bolts must be reamed parallel and the bolts turned to a driving fit. No thread shall come within the bolt hole. A washer at least ¼ inch thick shall be used under the nut. Bolts shall not be used in place of rivets. Carriage bolts may be used for fastening woodwork or nailing strips.

Portals and Bracing.

Latticed portals.

103. Through truss bridges shall have latticed portals rigidly connected to the end posts and top chords, and as deep as the headroom will permit. Provision shall be made in the end posts for bending strains from wind pressure.

Transverse bracing.

104. Trusses exceeding 20 feet in depth shall have transverse bracing attached to each post and to the top lateral struts.

Knee braces.

105. Trusses 20 feet or less in depth shall have knee braces at each immediate panel point, and connected to the vertical posts and top lateral struss.

Low trusses.

106. Low trusses and lattice girders shall be firmly stayed by knee or vertical braces extending from the top chords to the floor beams or transverse struts.

Stiff bracing.

107. Portal, lateral, and transverse bracing must be rigid and be composed of rolled shapes, with riveted connections. Such bracing must be carefully tightened to take tension. Laterals shall be fastened by not less than three rivets.

End struts.

108. All bridges must have lateral struts at the ends unless the end floor beams act as such.

Sagging and rattling.

109. Members of the web, lateral, longitudinal or transverse systems shall be securely riveted at their intersections to prevent sagging and rattling

Lateral bracing plane of chord.

110. Lateral bracing shall be in the plane of the chord which it braces.

Hand Railings.

Hand railings.

111. Hand or guard railings not less than 4 feet in height shall be placed on each side of the superstructure. They shall be galvanized iron pipe or steel lattice, rigidly attached and braced and shall extend beyond the ends of the steel superstructure as required by the Engineer.

Approach handrails.

112. Handrails extending beyond the steel superstructure shall be provided with iron or steel posts embedded in concrete to a depth of 18 inches. The ends of such hand rails shall be provided with iron or steel newel posts of such design as the Engineer may approve. Handrail posts beyond the superstructure shall be set and grouted to true line and grade by the Contractor.

Steel lattice.

113. The openings in steel lattice railings in the lower half of the fence shall not exceed 8 inches to a side, and the bottom rail shall be not more than 6 inches clear from the felloe guard. Lattice bars shall be inclined at an angle of about 60 degrees to the horizontal, and shall have neatly rounded ends. There shall be a rivet at each intersection.

Strength of top flange.

114. The top flange of railings shall be proportioned to withstand a transverse horizontal thrust of not less than 60 pounds per lineal

Posts and supports.

foot. Handrails shall be firmly supported laterally at panel points, and at such other points as may be necessary to maintain the strength of 60 pounds per lineal foot horizontally. On beam spans, hand railing shall be supported at intervals not exceeding twelve feet.

Pipe or lattice railing.

115. On bridges without foot walks, pipe handrails shall consist of preferably three lines of 1½ inch inside diameter galvanized iron pipe on both sides of the bridge, to be securely attached to verticals or diagonals of the truss to maintain the required strength. Handrails for sidewalks shall preferably be lattice and the lower angle shall preferably be 1 inch above the top of the concrete sidewalk.

Expansion joints.

116. Where necessary, or directed by the Engineer, expansion joints must be provided in handrails at the sliding ends of all spans.

Sidewalks.

Sidewalk brackets and thickness of floor.

117. Where sidewalks are required they shall preferably be placed outside the trusses and supported by longitudinal stringers resting on brackets. The thickness of reinforced concrete sidewalks shall be not less than 4 inches and the surface of the walk shall slope towards the roadway at the rate of ¼ inch per foot. The surface of the sidewalk shall be blocked off into panels and rolled with a dotting wheel.

Trestle Towers.

Columns in bents and towers.

118. Trestle bents shall preferably be composed of two columns. Towers shall be composed of two bents. Each tower shall be thoroughly braced in both directions and have struts between the feet of the columns. Anchor bolts for towers and similar structures shall be long enough to engage a mass of masonry, the weight of which is at least one and one-half times the uplift.

Struts anchorage.

119. The struts at the foot of towers shall be strong enough to slide the movable shoes with the bridge unloaded. Tower footings and bed plates shall be planed on all bearing surfaces and shall be slotted to provide for temperature movement.

Plate Girders.

Depth.

120. The depth of plate girders shall preferably be not less than 1/12 of the span, centre to centre of bearings.

Compression flanges.

121. The sectional area of the compression flange shall be not less than the gross sectional area of the tension flange, and shall be stayed against lateral deflection at intervals not exceedings 16 times its width.

Stress calculation.

122. The depth for calculation shall be the distance between centres of gravity of the flanges, unless this exceeds the distance from back to back of angles, in which case the latter dimension will be used. Plate girders shall be proportioned either by the moment of inertia of their net section; or by assuming that the flanges are concentrated at their centres of gravity, in which case ⅛ of the gross section of the web, if properly spliced, may be used as flange section.

Sway bracing.

123. Through plate girders shall have knee braces or gusset plates running from the top flange of the girder to each floor beam or transverse strut.

Flange plates.

124. Heavy sections of angles are to be used with as few cover plates as possible. When flange plates are used, at least one-half of the flange section shall preferably be angles. Plate girders shall preferably have one flange plate extending the full length of the girder; other plates shall extend at least two rows of rivets at each end beyond their theoretical length.

Web-plates.

125. Webs of plate girders shall, if possible, be in one piece, but where this is not practicable they shall be fully spliced for maximum shear at the splice, and sufficient to transfer bending stress in that part of the web estimated as flange area. Web plates may be set in from the backs of angles ⅛ inch except in girders without cover plates, where they shall be flush with the backs of the angles.

Rivets connecting flanges.

126. Rivets connecting the web and flanges shall be sufficient in number to transfer the increase in flange stress between any two points, together with any load applied directly to the flange.

Spacing.

127. The stiffeners, in girders over four (4) feet in depth, are to be placed a distance apart, centre to centre, not exceeding the depth of the full web plate.

In girders under four (4) feet in depth they may be placed four (4) feet apart.

If unequally spaced the distance between them will gradually decrease towards the end.

Web stiffeners.

128. There shall be web stiffeners, generally in pairs, over bearings, at points of concentrated loading, and at other points where the thickness of the web is less than 1/60 of the unsupported distance between flange angles. These stiffeners, including fillers, shall be proportioned to resist the maximum shear, as a column, considered one-half the depth of the girder in length. The rivet connection of the web shall be proportioned to transfer the total shear to the column.

Fillers.

129. Fillers, under stiffeners, shall be the same thickness as flange angles and as wide as stiffeners.

End stiffeners.

130. End stiffeners and those under concentrated loads shall be on fillers and have their outstanding legs as wide as the flange angles will allow and shall fit tightly against them. Intermediate stiffeners may be offset or be on fillers and their outstanding legs shall be not less than 1/30 of the depth of the girder plus 1½ inch.

Rivet pitch.

131. The rivet pitch of stiffeners shall not exceed five (5) inches.

Masonry Diagram.

Masonry Diagram.

132. The diagram showing dimensions of bridge seats, joist wall (where used), ballast wall and essential clear measurements and elevations shall be supplied by the fabricators of the steel superstructure. The distance face to face of ballast walls shall be at least 2 inches greater than the measurement out to out of steel for structures 90 feet and less in length and 3 inches or more as required for structures over 90 feet out to out of steel.

Swing Bridges.

Supplementary specification to be issued.

133. Bridges over navigable channels shall be designed in accordance with the requirements of this specification, also the regulations of the Dominion Government respecting bridges over such channels and such other supplementary specification as may be issued by the Engineer.

Painting.

Shop painting.

134. All metal before leaving the shop shall have loose scale and rust thoroughly removed, and be given a shop coat of paint, which must be worked into all joints and open spaces. The shop paint must be dry before loading on the cars. Painting shall be done by skilled workmen.

Contact surfaces.

135. Surfaces in contact with one another shall each be painted before being riveted together.

Inaccessible surfaces.

136. All surfaces not accessible after erection shall receive two coats of paint, the metal to be perfectly cleaned before painting.

Coating machined surfaces.

137. All machined surfaces shall be coated before shipment with white lead mixed with tallow.

Painting after erection.

138. After erection all rubbed spots and field rivets shall be carefully cleaned and painted. When dry, the entire metal work shall be thoroughly and evenly painted with two additional coats of paint of different shades. Recesses which might retain water, or through which water could enter, must be properly drained or filled with waterproof material. Field rivets are to be given one coat of approved paint on the day they are driven. Painting will not be allowed in wet or freezing weather. The steel, when paint is applied, must be dry.

Standard bridge paint.

139. Unless otherwise specified, previous to the signing of the contract, the paint used shall consist of red lead, lamp-black, and pure raw linseed oil. The shop coat shall contain 20 pounds of red lead, 4 ounces of lamp-black, and 1 gallon of linseed oil; the first field coat to be 15 pounds of red lead, 10 ounces of lamp-black and one gallon of linseed oil; and the final coat to be 15 pounds of red lead, 13 ounces of lamp-black and one gallon of linseed oil. Each coat is to be thoroughly dry before the next is applied. The red lead and lamp-black shall first be mixed dry, the linseed oil added, and the mixture stirred to a uniform consistency, and maintained at such consistency by frequent stirring during application. Only a sufficient quantity for immediate use shall be mixed. Thinning and drying ingredients will not be allowed. The two field coats of paint applied to handrails and handrail posts shall preferably be white and made up by mixing 25 pounds of pure white lead, one gallon of linseed oil, one pint turpentine and not more than one gill of Japan driers.

Alternative bridge paint.

140. The shop coat of paint shall consist of red lead, lamp black, and pure raw linseed oil, mixed in the proportions of 20 pounds of red lead, 4 ounces of lamp black and one gallon of linseed oil. The two field coats are to consist of a pigment composed of 60 per cent. pure white lead, 30 per cent. zinc oxide and 10 per cent. of asbestine, mixed with a vehicle composed of raw linseed oil, turpentine and Japan driers mixed in the proportions of 1 gallon of raw linseed oil to 1 pint of turpentine to 1 gill of driers. The desired colour is to be procured by the addition of a sufficient quantity of lamp black. The pigment, vehicle and colouring material are to be mixed in such proportions so as to produce a paint that will weigh 20 pounds per imperial gallon. The paint for both shop and field coats is to be machine ground and mixed in a paint factory approved by the Engineer and is to be put up and shipped in 5 gallon containers. One gallon or two gallon containers may be used for small quantities.

No thinning of this paint will be allowed. The first field coat is to be dark grey and the second field coat a pearl grey. Colour charts showing the desired colours will be supplied by the Department. If a factory-mixed white paint for guardrails is required, it will conform to the specification for the field coats except (1) no lamp black will be used, (2) extra pale refined linseed oil will be used in place of raw linseed oil. This paint must be a pure white in colour.

Manufacture. The pigments entering into composition of the paint shall be thoroughly machine ground together in oil and thinned by the addition of oil, turpentine and drier to the extent specified. The quantity of vehicle specified above shall include the oil used in grinding.

Inspection. The Contractor for these paints shall allow the Engineer or the Inspector free access to all parts of his shops while work on these paints is being carried out; also the Contractor shall give the Engineer or the Inspector every reasonable facility to enable him to ensure that these paints are being made in accordance with this specification.

Samples. Before commencing work on the manufacture of these paints, the Contractor shall notify the Engineer or Inspector in writing and shall furnish the Inspector with separate samples of all pigments and vehicles to be used in such paints; each such sample to be clearly labelled and marked to show the name of the material and the name and number of the paint in which it is to be used.

Containers. All paints shall be shipped in wooden cased metal cans, each containing not more than 5 imperial gallons. The Inspector may stamp each sealed container of paint under this specification with a private mark. Cans and wooden cases shall be well made and shall be in good condition and absolutely free from all signs of leakage at the time of shipment. Cans shall be so constructed that the contents can be thoroughly and completely stirred.

Marking. Each and every container must be clearly marked to show the following information:—(*a*) "The paint in this container conforms to the formula specified in clause No. 140 of the Ontario Department of Public Highways General Specifications for Steel Highway Bridges, 1923.

(Sgd.) Name of Paint Manufacturer."

(*b*) Location of paint mill.
(*c*) Name of purchaser and contract number.
(*d*) Quantity of paint in the container in imperial gallons.
(*e*) Tare weight of container in pounds.
(*f*) Net weight of contents in pounds.
(*g*) Date of filling container.
(*h*) A serial number, such, that paint may be identified with Inspector's reports at any time after shipment.
(*i*) "Bridge Paint No. 1
Shop coat."
or
"Bridge Paint No. 2
1st Field coat."
or

"Bridge Paint No. 3
2nd Field coat."
or
"Guard Rail Paint No. 4
White."

Red lead.

141. The dry red lead must be of the best quality, have a good bright colour, be free from all adulterants and shall contain not less than 85 per cent. by weight of red lead (Pb_3O_4), and 15 per cent. pure lead monoxide (PbO). It must contain less than 0.1 per cent. of metallic lead, and is to be of such fineness that not more than 0.5 per cent. remains after washing with water through a No. 21 silk bolting cloth sieve.

Linseed oil.

142. The oil must be pure raw linseed oil as free as possible from foots, and well clarified by settling and age. The oil shall meet the requirements of the American Society for Testing Materials, standard specification D 1-15 for this material.

Lampblack.

143. The lampblack must be of good quality and unadulterated. The use of ground coal or other substitutes will not be allowed.

White lead.

144. White lead (basic carbonate of lead) shall approach the composition $2PbCO_3,Pb(OH)_2$. It shall not contain more than a trace of sulphur dioxide, not more than 2.50 per cent. of sandy lead, not more than 0.10 per cent. of organic matter, not more than 0.10 per cent. of metallic lead, not more than 0.50 per cent. of lead sulphate, not more than 0.15 per cent. of acetic acid.

It shall be of such fineness that not more than 0.50 per cent. remains after washing with water through a No. 21 silk bolting cloth sieve.

Zinc oxide.

145. Zinc oxide (ZnO) shall be 95 per cent. pure and shall not contain more than a trace of sulphur dioxide.

Asbestine.

146. Asbestine shall be pure natural hydrated magnesium silicate. It shall be of a fibrous nature and shall be so finely ground that 98 per cent. will wash through the standard 325 mesh sieve. It shall contain not more than a trace of calcium carbonate.

Turpentine.

147. Turpentine shall meet the specifica ions of the American Society of Testing Materials standard specifications D 13-15 for this material.

Drier.

148. Drier shall consist of a clear solution of lead or manganese salts in linseed oil and turpentine (or turpentine substitute). It shall contain no resin or varnish gums, and not more than 70 per cent. shall volatilize at 450° F. When flowed on metal and baked for two hours at 212° F. it shall produce an elastic film. The flash point shall not be lower than 95° F., when tested in an open cup tester. When a mixture of 5 per cent. of drier with 95 per cent. pure raw linseed oil is flowed on a glass slab, which is then held nearly vertical, and is kept at a temperature of 70° F. with free access of air, the coating shall dry throughout, neither sticky nor brittle, in not over 3 hours.

Proprietary paints.

149. Where paint other than that described in this pecification is approved for use, it shall comply with such tests as may be prescribed by the Engineer, in addition to the following:

Fineness.

Fineness of pigment and covering power will receive special consideration and comparison of fineness shall be made in the following

manner: The paint having been first brought to a temperature of about 70° F. and then thoroughly stirred up, a single drop will be allowed to fall upon a horizontal clean sheet of glass. The glass will then be placed in a vertical position for one hour, at the expiration of which, no separation of pigment from vehicle should be noticeable. If the paint be too thick for a drop to run down the glass a distance of 3 inches in one hour, it shall be thinned with linseed oil to the necessary consistency for testing.

Drying.

150. Paint will not be accepted, the ordinary coating of which, when spread on glass, dries dust-proof in less than 10 hours, or more than 14 hours when kept at 70° F.

Consistency.

151. The paint should be of a proper working consistency, not too heavy to be brushed out without additional thinning, not thin enough to cause it to run, and must cover steel or iron surfaces thoroughly with two coats.

Rejection after test.

152. Shipments will be subject to test at all times and any failing to meet the requirements of this specification shall be returned to the shipper, who will pay freight both ways.

Guarantee.

153. The Manufacturer or Contractor will be required to guarantee that f the paint furnished cracks, flakes or powders within two years of date of application, sufficient approved paint will be furnished by them, free of charge, to repaint the work.

Inspection and Testing at the Shops.

Facilities for inspection.

154. The Manufacturer shall furnish all facilities for inspecting and testing the quality of workmanship at the shop where the material is manufactured.

Commencing work.

155. The purchaser shall be notified well in advance of the commencement of the work in the shop, in order that provision for inspection can be made.

Access to shops.

156. The Inspector shall have full access at all times to all parts of the shop where material under his inspection is being manufactured.

Acceptance of material.

157. The Inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time and at any stage of the work. If the Inspector, through an oversight, or otherwise has accepted material or work which is defective or contrary to the specifications, such material, no matter in what stage of completion, may be rejected by the purchaser.

Nameplate.

Name-plate.

158. A neat and substantial name plate shall be rigidly attached to all steel bridges at such location as the Engineer may direct. The plate shall contain the name of the Contractor, the date and any other information required by the Engineer.

STEEL.

(*In substantial agreement with the C.E.S.A. specifications for structural carbon-steel*).

Manufacture.

Process.

159. The steel shall be made by the open-hearth process.

Chemical Properties and Tests.

Chemical composition.

160. The steel shall conform to the following requirements as to chemical composition:

		Structural Steel	Rivet Steel
Phosphorus	Acid	not over 0.06	not over 0.04 per cent.
	Basic	" 0.04	" 0.04 "
Sulphur		" 0.05	" 0.045 "

Ladle analyses.

161. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the Engineer and shall conform to the requirements specified above.

Check analyses.

162. Analyses may be made by the Engineer from finished material representing each melt. The phosphorus and sulphur content thus determined shall not exceed that specified above by more than 25 per cent.

Physical Properties and Tests.

Tension tests.

163. The material shall conform to the following requirements as to tensile properties, except as modified hereinafter:

Properties Considered	Structural Steel	Rivet Steel
Tensile strength, lbs. per sq. in	55 000–65 000	46 000–56 000
Yield Point, min. lbs. per sq. in	0.5 tens. str.	0.5 tens. str.
Elongation in 8 ins. min. per cent	$\frac{1\ 500\ 000}{\text{Tens. str.}}$	$\frac{1\ 500\ 000}{\text{Tens. str.}}$
Elongation in 2 ins. min. per cent	22	.....

Specimen tension-tests of eye-bar material.

164. In order to meet the required minimum tensile strength of full-sized annealed eye-bars, the Engineer may determine the tensile strength to be obtained in specimen tests; the range shall not exceed 14,000 pounds per square inch, and the maximum shall not exceed 74,000 pounds per square inch. The material shall conform to the requirements as to physical properties (other than tensile strength) specified under "Tension Tests" above, and under "Modifications in Elongation" and "Bend Tests" below.

Yield point.

165. The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in elongation.

166. For structural steel over $\frac{3}{4}$ inch in thickness, a deduction of one from the percentage of elongation in 8 inches specified above shall be made for each increase of $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch to a minimum of 18 per cent.

167. For structural steel under 5/16 inch in thickness, a deduction of 2.5 from the percentage of elongation in 8 inches specified above shall be made for each decrease of 1/16 inch in thickness below 5/16 inch.

Bend tests.

168. The test specimens for plates, shapes and bars (except those for eye-bar flats, for pins, rollers and other bars when 1x$\frac{1}{2}$ inch in section, and for rivet steel) shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: for

material ¾ inch or under in thickness, flat on itself; for material over ¾ inch to and including 1¼ inches in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

169. The test specimens for eye-bar flats shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: for material ¾ inch or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; for material over ¾ inch to and including 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to three times the thickness of the specimen.

170. The test specimens for pins, rollers and other bars when 1x½ inch in section, shall bend cold through 180 degrees around a one-inch pin without cracking on the outside of the bent portion.

171. The test specimens for rivet steel shall bend cold through 180 degrees flat on themselves without cracking on the outside of the bent portion.

Full-Size Tests.

Tests of eye-bars.

172. Full-size tests of annealed eye-bars shall conform to the following minimum requirements as to tensile properties:

Tensile strength	lbs. per sq. inch, 54 000
Yield point	lbs. per sq. inch, 29 000
Elongation in 18 ft	per cent, 10

173. The yield point shall be determined by the halt of the gauge of the testing machine.

Test Specimens.

Test specimens.

174. Tension and bend test specimens shall be taken from rolled steel in the condition in which it comes from the rolls, except that tension and bend test specimens for pins and rollers shall be taken from the finished bars, after annealing when annealing is specified.

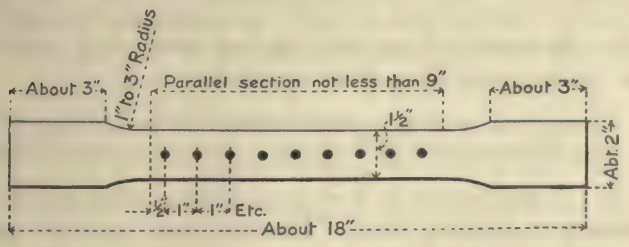


Fig. 1.

175. Tension and bend test specimens for plates, shapes and bars, except as otherwise specified herein, shall be of the full thickness of material as rolled. They may be machined to the form and dimensions shown in Fig. 1, or with both edges parallel; except that bend test specimens for eye-bar flats may have three rolled sides.

176. Tension and bend test specimens for plates and tension test specimens for eye-bar flats over 1½ inches in thickness may be machined to a thickness or diameter of at least ¾ inch for a length of at least 9 inches.

177. Tension test specimens for pins, rollers, and bars (except eye-bar flats) over 1½ inch in thickness or diameter may conform to the dimensions shown in Fig. 2. In this case, the ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial. Bend-test specimens may be 1 x ½ inch in section. The axis of the specimen shall be located at any point midway between the centre and surface and shall be parallel to the axis of the bar.

178. Tension and bend test specimens for rivet steel shall be of the full-size section of the bars as rolled.

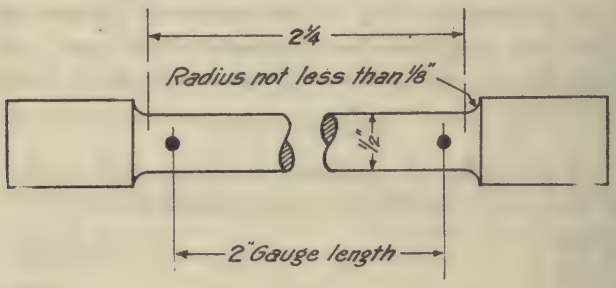


Fig. 2.

Note:—The gauge-length, parallel portions and fillets shall be as shown; but the ends may be of any form which will fit the holders of the testing-machine.

Number of tests.

179. One tension and one bend test shall be made from each melt; except that if material from one melt differs ⅜ inch or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled. The Contractor shall supply at his own cost, from each melt, at least one bending and one tension piece; also the labour and tools necessary to make the test; and if the requirements are not complied with, such additional test pieces as the Inspector may deem necessary.

180. If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

Retests.

181. If the percentage of elongation of any tension test specimen is less than that specified under "Tension Tests" and any part of the fracture is more than ¾ inch from the centre of the gauge length of a 2-inch specimen or is outside the middle third of the gauge length of an 8-inch specimen, as indicated by scribe-scratches marked on the specimen before testing, a retest shall be allowed.

Character of fracture.

182. Test specimens of structural or rivet steel shall show a fracture of uniform, silky appearance; of bluish grey or dove colour; and entirely free from granular, black and brilliant specks.

Finish.

183. Finished rolled material shall be free from cracks, flaws, injurious seams, blisters, ragged and imperfect edges, and other surface defects. It shall have a smooth finish, and shall be straightened in the mill before shipment. Defects.

Permissible Variations in Weight and Thickness.

184. The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent. from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations. One cubic inch of rolled steel is assumed to weigh 0.2833 pound. Permissible variations.

185. When ordered to weight per square foot, the weight of each lot in each shipment shall not vary from the weight ordered more than the amount given in Table I.

The term "lot" applied to Table I means all of the plates of each group-width and group-weight.

186. When ordered to thickness, the thickness of each plate shall not vary more than 0.01 inch under that ordered.

The overweight of each lot in each shipment shall not exceed the amount given in Table II.

The term "lot" applied to Table II means all of the plates of each group-width and group-thickness.

TABLE I.

PERMISSIBLE VARIATIONS OF PLATES ORDERED TO WEIGHT

Ordered Weight, lbs. per sq. ft.	Permissible Variations in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Ordered Weights																		Ordered Weight, lbs. per sq. ft.
	Under 48 in.		48 to 60 in., excl.		60 to 72 in., excl.		72 to 84 in., excl.		84 to 96 in., excl.		96 to 108 in., excl.		108 to 120 in., excl.		120 to 132 in., excl.		132 in. or over		
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	
Under 5	5	3	5.5	3	6	3	7	3	...	...	...	...	...	...	...	...	...	...	Under 5
5 to 7.5 excl.	4.5	3	5	3	5.5	3	6	3	...	...	...	...	...	...	...	...	...	...	5 to 7.5 excl.
7.5 " 10 "	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	...	...	...	...	7.5 " 10 "
10 " 12.5 "	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3	10 " 12.5 "
12.5 " 15 "	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	12.5 " 15 "
15 " 17.5 "	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	15 " 17.5 "
17.5 " 20 "	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	17.5 " 20 "
20 " 25 "	2	2	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	20 " 25 "
25 " 30 "	2	2	2	2	2.5	2	2.5	2.5	3	2 5	3.5	3	4	3	4.5	3	5	3	25 " 30 "
30 " 40 "	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	30 " 40 "
40 or over	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	40 or over

NOTE:—The weight per square foot of individual plates shall not vary from the ordered weight by more than one and one-half times the amount given in this table.

TABLE II.

PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS

ORDERED THICKNESS, INCHES	PERMISSIBLE EXCESS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, EXPRESSED IN PERCENTAGES OF NOMINAL WEIGHTS									ORDERED THICKNESS, INCHES
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	..	1/8 to 3/16 excl.
3/16 " 1/4 "	7	8	9	10	12	..	..	..	..	3/16 " 1/4 "
1/4 " 5/16 "	6	7	8	9	10	12	14	16	19	1/4 " 5/16 "
5/16 " 3/8 "	5	6	7	8	9	10	12	14	17	5/16 " 3/8 "
3/8 " 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 " 7/16 "
7/16 " 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 " 1/2 "
1/2 " 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 " 5/8 "
5/8 " 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 " 3/4 "
3/4 " 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 " 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

NOTE:—The weight of individual plates ordered to thickness shall not exceed the nominal weight by more than one and one third times the amount given in this table.

Marking.

187. The name or brand of the Manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that rivet and lattice bars and other small sections shall, when loaded for shipment, be properly separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

Annealing.

188. All members partly heated in working shall be carefully annealed.

Temperature of working.

189. No forging shall be done under red heat.

Inspector.

190. An Inspector may be appointed by the Engineer for mill and shop inspection. The Engineer or Inspector shall at all times have full access to the mills and shops where material under inspection is being manufactured.

Test pieces.

191. Test pieces shall be of such dimensions and shall be cut from the finished material in such manner as the Engineer or Inspector appointed by him may require.

Stock material.

192. When the material used is taken from shop stock, it shall be free from pitting and rusting, and shall have been protected in such manner as will fully maintain its strength and durability.

Rejected material.

193. Material which does not pass the specified tests shall be rejected. Acceptance at the mill or shop shall not prevent subsequent rejection, should defects develop.

Steel castings.

194. Steel castings shall be made of acid open hearth steel, must be sound and free from blow holes, true to pattern and smooth in finish. Steel castings shall be uniformly annealed.

Concrete reinforcement mesh.

195. Material other than bars or wire used in reinforcing concrete shall be of structural steel grade and have a carbon content not over 0.12 per cent.

196. Iron castings shall be of tough grey iron, free from cold shuts or blow holes, true to form and thickness and of workmanlike finish. Test pieces one inch square cast from the same metal in sand moulds, shall sustain a central load of 500 pounds on a clear span of 4½ feet when tested in the rough bar. A blow from a hammer, on a rectangular edge of the casting shall produce an indentation without flaking the metal. Iron castings.

197. The 1920 General Specifications for Concrete Highway Bridges, Ontario, shall apply to and govern the construction of the substructure and other parts of the bridge covered by such specifications. Concrete specifications to apply.

Standard Plans.

198. The 1917 General Plans for Steel Highway Bridges, as issued by the Department of Public Highways, shall preferably be used where such standards apply. General plans to be used when possible.

Timber.

199. Timber unless otherwise specified shall be sound oak, southern longleaf yellow pine, Douglas fir, white pine, red or Norway pine, spruce, tamarac or cedar. It shall be sawn to standard size, full length, square cornered and straight; shall be close grained and free from defects such as injurious ring shakes and cross-grain, unsound or loose knots, knots in groups, decay, or other defects that will materially impair its strength. All timber shall be subject to inspection and culling by the Engineer. Timber.

Timber Floors.

200. Timber floors where specifically permitted by the Engineer shall preferably be laid on steel stringers. When timber joists are used they shall have a width or thickness of not less than 3 inches nor one-fourth of their depth They shall lap by each other so as to have a full bearing on the floorbeams, and be bolted together, being separated by a ½-inch metal separator for free circulation of air. Steel or timber joists.

201. Timber floors laid on steel stringers shall be spiked to nailing strips bolted to the stringers, bolts to be not less than ½ inch diameter and spaced not more than 3 feet apart. Two 6-inch wire spikes shall be used to fasten each plank to each stringer or nailing strip. Fastening planking.

202. Timber planking shall preferably be cedar, tamarac Douglas fir or longleaf southern yellow pine not less than 3 inches in thickness. Planking shall be laid with the heart down. Wheelguards not less than 6 inches by 4 inches shall be provided on each side of the roadway. They shall be blocked up from the roadway by 2-inch blocks spaced not over 4 feet apart and held by ¾-inch bolts passing through wheelguard, blocking and flooring, and caught under or passed through the flange of stringer. Scuppers shall be provided as required by the Engineer and located so as to discharge all water clear of steelwork. Kind of planking. Drainage of timber floors.

Preservation of Timber.

203. Creosote oil, where used as a wood preservative for timber flooring, shall comply with the following requirements: Specification for creosote oil.

The oil shall be the best obtainable grade of coal-tar creosote; that is, it shall be a pure product obtained from coal gas tar or coke

oven tar and shall be free from any tar, including coal-gas tar and coke-oven tar, oil or residue obtained from petroleum or any other source; it shall be completely liquid at thirty-eight (38) degrees centigrade and shall be free from suspended matter; the specific gravity of the oil at thirty-eight (38) degrees centigrade shall be not less than 1.03 or more than 1.07. When distilled by the common method—that is, using an eight (8) ounce retort, asbestos covered, with standard thermometer bulb one-half (½) inch above the surface of the oil—the creosote calculated on the basis of the dry oil, the distillate shall not exceed one-half (½) of one (1) per cent. at one hundred and fifty (150) degrees centigrade and shall not be less than thirty (30) nor more than forty (40) per cent. at three hundred and fifteen (315) degrees centigrade. The oil shall not contain more than two (2) per cent. water.

Inspection of creosote oil.

204. The Engineer or his authorized assistants shall have access at all times to the factory where the oil is produced, and shall be furnished with whatever test samples may be required in order that the materials used can be determined to be in accordance with the foregoing requirements. The manufacturer shall also submit satisfactory proof of the origin of all materials entering into the composition of the finished product.

Creosoted Wood Block.

Gauges required.

205. The manufacturer of the blocks shall equip his plant with all necessary gauges, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications are fulfilled.

Dimensions of blocks.

206. Blocks shall be of uniform dimensions truly rectangular and shall be 3 inches wide, 4 inches in depth parallel to the fibre and 6 inches to 10 inches long. No variation greater than 1/16 inch shall be allowed in the width or depth or ¼ of an inch in length. Blocks shall have projections on one side and one end, such that a spacing of 3/16 inch will be maintained around the blocks when laid.

Kind of timber.

207. Blocks shall be made from longleaf southern yellow pine, Norway pine, Douglas fir or tamarac, but only one kind of wood shall be used in one stretch of pavement. Blocks shall be well manufactured, full size, saw butted, all square edge and shall be free from unsound, loose or hollow knots, worm holes and knot holes, through shakes and round shakes that show on the surface. In yellow pine timber the annular rings shall average not less than six to the inch between the third and fourth inch, measured radially from the heart, and in no case shall be less than four rings to the inch. Other timber approved of by the Engineer and used for blocks shall be cut from first-class material in every respect and shall be of the same grade as that defined for southern yellow pine. The blocks shall average 80 per cent. heart wood and all timber herein shall be properly air-dried or cured and subject to inspection before being cut into blocks. Blocks shall be subject to the inspection and approval of the Engineer before, during and after treatment, and may be re-inspected at any time. All parts of the block shall be thoroughly impregnated with preservative and shall contain not less than 14 pounds of such preservative per cubic foot of timber.

208. All timbers for nailing strips, wheel guards, joists, or floor plank shall be of the same kind and grade of timber used in manufacturing the wood block. The treatment and creosotin of such timber shall be identical with that described herein for the treatment of wood blocks. Treatment of timber.

209. When plant inspection is made on dimension timber, the determination of the quality and quantity of creosote shall be made as described herein for creosoted blocks, except that the preliminary weighing of the timber shall be made after the steam treatment has been completed. Tests of dimension timber.

210. Should the creosoting company be notified in writing that plant inspection will be waived on dimension timber, no field determination of quantity or quality of creosote will be made, but the creosoting company will be required to furnish a certified statement signed by proper officers of the company, which statement shall indicate the amount of creosote oil injected and remaining in the timber, and the results of analysis of the oil, which analysis shall be made in accordance with the methods heretofore described in these specifications. Where plant inspection waived certified statement required.

211. For treatment, blocks will be placed in properly constructed cages in an approved steam heated retort for one (1) hour and subjected to a temperature of not less than 180 degrees Fahrenheit and not more than 240 degrees Fahrenheit. At the end of one hour a vacuum of not less than 22 inches shall be applied for one and one-half (1½) hours, and during the time this vacuum is applied the temperature in the cylinder shall be maintained at not less than 180 degrees Fahrenheit and not more than 240 degrees Fahrenheit. Steam heat and vacuum treatment of blocks.

212. The oil at a temperature of between 180 and 190 degrees Fahrenheit shall then be admitted and pressure applied. The pressure shall be gradually raised during a period of at least two and one-half (2½) hours and until an average of fourteen (14) pounds of preservative oil as specified herein has been forced into each cubic foot of the blocks, when the free oil may be pumped from the cylinder. When the cylinder is under pressure the temperature of the oil shall be at least 165 degrees Fahrenheit. Forcing oil into wood.

213. After treatment the blocks shall remain in the cylinder for from thirty minutes to one hour and shall then be removed. After manufacture the blocks shall be protected from the sun and shall be held for forty-eight (48) hours before shipment. Protection after treatment.

214. The waterproof qualities of the blocks shall be such that before or after delivery and after being dried in an oven at a temperature of 100 degrees Fahrenheit for twenty-four (24) hours and weighed, they shall not gain more than five (5) per cent. in weight when immersed in clean water. Test for waterproof qualities.

215. After delivery, acceptance or refusal of any car lot of blocks shall be based upon the result of test of any ten blocks picked at random. Test sample.

216. These blocks shall be tested for waterproof qualities, annular rings or any other test specified herein.

217. Should any blocks be brought to the work upon the bridge where they are intended for use without being properly selected or culled, so as to meet the requirements of this specification, the Engineer Selecting or culling blocks.

may refuse such blocks and they shall at once be removed from the work.

Kerbs for blocks.

218. Blocks shall be held at the edges of the floor by a steel channel kerb riveted to the stringers and braced to the truss at panel points, or by a 4 inch by 4 inch creosoted timber bolted to the flange of the outside stringers by ¾ inch bolts spaced at 3 feet centres.

Laying blocks.

219. All defective blocks shall be culled before the laying of the floor is commenced. The blocks may be laid upon a cushion composed of hot tar swabbed on creosoted floor plank not less than three inches in thickness. Creosoted wood blocks shall preferably be laid on a reinforced concrete foundation protecting all steelwork with a covering of not less than two inches. The concrete shall be floated to the true crown of the roadway. Blocks shall be set in a mortar cushion one inch thick placed immediately before laying the blocks and composed of one part Portland cement to two parts clean coarse sand. The blocks shall be laid in straight and parallel courses with the grain vertical and at such angles with the kerb as the Engineer may direct. When laid upon planking, each block shall be toenailed to the planking with one nail not less than 2½ inches long. Each course of blocks shall be of uniform width and depth with end joints broken by a lap of at least three inches. Whole blocks shall be used except when starting courses, cutting closures or where permitted by the Engineer. The joints between blocks shall be loose but shall not exceed 3/16 inch and the blocks shall not be driven together. In laying the blocks the pavers shall stand on the block previously laid. Careful attention shall be given to securing proper alignment of blocks during the laying of the pavement.

Applying paving filler.

220. After laying, a coating of clean, dry sand shall be spread over the blocks and broomed into the joints between the blocks so that the joints are one-third filled. The blocks shall then be flushed with an approved bituminous paving filler heated to at least 300 degrees Fahrenheit, which shall be spread over the surface and forced into all joints with rubber squeegees until the joints are filled within about one inch of the top surface of the blocks. A coating of clean, dry sand shall then be spread and broomed so as to fill the joints, after which a coating of screened sand one-half inch in depth shall be spread over the entire floor surface. Traffic shall not be permitted on the floor until the written order of the Engineer is obtained.

General Conditions.

Work and material.

221. The Contractor shall perform all work and furnish all materials incidental to or in any way connected with the erection and maintenance of the structure until its final acceptance by the Municipality. Unless otherwise specified, the Contractor shall furnish all falsework and staging, shall erect and adjust all metal work, and shall put in place all flooring, guards, railings, attachments, etc., complete, to the lines and grades given by the Engineer.

Old structure at site.

222. Where it is necessary to remove an old structure before work can be commenced on the new bridge, the material in the old structure shall be and remain the property of the Municipality. The Contractor shall remove the old structure and the material so removed

shall be piled within two hundred feet of the structure as the Engineer may direct unless otherwise more specifically provided for.

Methods and appliances.

223. The Contractor shall use such methods and appliances for the performance of all the operations connected with the work embraced under this specification, as will secure a satisfactory quality of work, and a rate of progress which will secure the completion of the work within the time specified.

Inspection of material.

224. All material used in the work, or any portion thereof, included under this specification, shall be subject to the inspection and approval of the Engineer. The supply of each and all material or materials must be so gauged that a sufficient quantity will be kept on hand by the Contractor to allow ample time for testing and examination by the Engineer without delay to the work of construction.

Inspection.

225. The Contractor shall, free of cost, furnish all facilities and test pieces for the inspection and testing of materials and workmanship. Inspection of the work done shall not relieve the Contractor of his obligation to furnish proper material and perform sound and reliable work.

Rejected material.

226. All material rejected by the Engineer shall be immediately removed from the site of work by the Contractor. In case the Contractor should refuse to remove or replace any rejected work or material within forty-eight hours after written notice from the Engineer, such work or material shall be removed by order of the Engineer at the Contractor's expense.

Defective work or material.

227. Any defective work or material that may be discovered by the Engineer before the final acceptance of the work, or before final payment has been made, shall be removed and replaced by the Contractor with work and material which shall conform to the spirit of the specification; failure or neglect on the part of the Engineer to condemn or reject bad or inferior work or materials shall not be construed to imply an acceptance of such work or materials.

Refuse materials.

228. On the completion of the work all surplus or refuse material, falsework, piling or other obstructions shall without unnecessary delay be removed by the Contractor. If not removed within forty-eight hours after notice in writing so to do from the Engineer, it shall be removed by the Engineer at the Contractor's expense.

Interference with travel.

229. The Contractor shall at all times carry on the work in such a manner as not to interfere with travel more than is absolutely necessary for the faithful performance of the work, and shall not obstruct any thoroughfare by land or water except by written order of the Engineer.

Prevention of accident.

230. The Contractor shall during the progress of the work use all proper precautions by good and sufficient barriers, red lights, or watchmen, for the prevention of accident, and he shall indemnify and save the Municipality from all suits and actions and all costs and damages occasioned by the negligence or carelessness of the Contractor, his agents or employees.

Notices by contractor.

231. All necessary notices to waterworks, gas, electric light or power, telephone or telegraph officials, owners or occupants of property, or other interested parties, shall be given by the Contractor.

Interpretation of specifications.

232. The decision of the Engineer shall be final in case of ambiguity in the plans and specifications or doubt as to the correct interpretation thereof.

Stopping work.

233. The Engineer may stop any portion of the work if, in his judgment, the weather is such as to prevent the same being done properly. No allowance of any kind will be made for such stoppage, except an extension of time for the completion of the work as herein provided.

Extension of time.

234. An extension of time may be granted by the Engineer in the event of the work being delayed beyond the prescribed time for completion resulting from delays caused by carriers, or the elements, general strikes, accidents or other causes beyond the Contractor's reasonable control.

Alteration in plans and specifications.

235. Should any changes or alterations in these specifications or plans in connection therewith be at any time deemed necessary by the Engineer, he shall have authority to make such changes or alterations, and, unless otherwise provided for in writing, an amount proportionate to the prices contained in the tender upon which the contract was awarded shall be added to or deducted from the original amount of the contract.

Disorderly employees.

236. Any disorderly or incompetent person or persons who may be employed on the work shall be removed when required by the Engineer, and no person so removed shall thereafter be employed upon any portion of the work.

Payment of workmen.

237. The Contractor shall punctually pay the workmen employed on the work comprised in these specifications, in cash current. Final payment for the work shall not be made until satisfactory vouchers are furnished the Engineer by the Contractor, showing all wages and accounts for materials and implements used in the work to have been paid.

Unforeseen loss.

238. All loss arising from unforeseen obstruction or difficulties encountered in the performance of the work under these specifications, or from delay or hindrance from any cause during the prosecution of the same, shall be sustained by the Contractor. He shall assume all risks from floods, storms and casualties of every description.

Assignment of contract.

239. The work to be performed under this specification, or any part thereof, or any moneys or orders payable under this contract, shall not be assigned nor sub-let by the Contractor without the pre-sanction of the Municipality. No sub-contract shall, under any circumstances, relieve the Contractor of his liabilities and obligations under this contract. Should any sub-contractor fail to perform the work undertaken by him in a satisfactory manner, and should this provision be violated, the municipality may, at their option, end and terminate such contract.

Abandonment of contract.

240. Should the work under this specification be abandoned by the Contractor, or should at any time the Engineer judge and certify in writing that the said work, or any part of it, is unnecessarily delayed, or that the Contractor is violating any of the conditions or covenants of the contract, or is executing the same in bad faith, the Engineer shall notify the Contractor to discontinue all work under the contract. The Municipality may employ other parties to complete the work in such manner as they may decide, and use such materials as may be procured upon the site of the aforesaid work, and if necessary may procure other material for its completion, and charge the expense of the said labour and material to the Contractor, which

expense shall be deducted from any moneys due him under contract. In case these expenses shall exceed the sum which would have been payable under the contract, if the same had been completed by the said Contractor, he or his bondmen shall pay the amount of the excess to the Municipality upon notice from the Engineer.

Extra work.

241. Claims for extra work will not be allowed unless the written order of the Engineer, designating such work and rate of the payment to be made therefor, shall have been obtained before the work was undertaken.

Commencing work.

242. Work shall not be begun nor materials ordered until the necessary working drawings are approved in writing by the Engineer.

Instructions to contractor.

243. The Contractor, or his duly authorized agent or foreman, shall at all times while the work is in progress be on the ground, and instruction given by the Engineer to such agent or foreman shall be of the same effect as if given to the Contractor.

Engineer defined.

244. The word "Engineer", where and whenever used herein shall mean the Engineer or his authorized assistant, acting for or appointed by the Municipality, to have charge and oversight of the work; and the words "approved" or "approval" shall mean the approval of the Engineer.

Contractor defined.

245. The word "Contractor" wherever used herein, shall mean the party or parties agreeing to supply the material and perform the work to be done under this specification, and shall include the heirs, administrators, executors and assigns, also the legal representative or representatives of such party or parties.

Work defined.

246. "Work" shall mean all or any part of the work to be executed under the contract, whether completed or uncompleted, and may be as originally set forth or as varied by the Engineer, and any or all of the equipment, materials and labour supplied by or used by the Contractor.

Municipality defined.

247. The word "Municipality" wherever used in these specifications shall mean the municipal corporation purchasing the bridge, or the council of such municipality, or the warden, or the committee, or other person or persons duly authorized by the municipal council to act on behalf of such municipality.

Inspector defined.

248. The word "Inspector" wherever used in these specifications means any person or persons whom the Engineer or municipality may appoint for the purpose of assisting in the supervision and inspection of the work and materials.

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249. The foregoing general Specifications for Steel Highway Bridges are prepared and approved in accordance with section 459 of the *Consolidated Municipal Act*, 1914, as amended by 6 George V., Chapter 39. Previous general specifications are annulled.

GEO. HOGARTH,
Engineer of Highways.

Approved,
S. L. SQUIRE,
Deputy Minister of Highways.

Department of Public Highways,
Toronto, Ontario.
October 15th, 1923.

LIST OF PUBLICATIONS ISSUED BY THE DEPARTMENT OF PUBLIC HIGHWAYS.

Pub. No.	Title.
	Annual Reports.
	Annual Proceedings, Ontario Good Roads Association.
9.	Report of the Ontario Highways Commission, 1914.
10.	Regulations respecting Township Road Superintendents, 1916.
11.	Regulations respecting County Roads, 1920.
14.	Township Road Improvement, 1918.
15.	The Highway Traffic Act, 1923.
16.	General Specifications for Concrete Highway Bridges, 1920.
17.	General Specifications for Steel Highway Bridges, 1923.
18.	Highway Bridges, 1917.
19.	General Plans for Steel Highway Bridges, 1917.
20.	Description of Road Models Exhibit, 1917.
21.	Short Forms for Bridge Tenders, 1917.
22.	Report on Street Improvement, 1917.
23.	Bituminous Surfaces for Macadam Roads, 1917.
24.	Specifications for Bituminous Materials, 1917.
25.	County Road Legislation, as enacted by The Highway Improvement Act, The Ontario Highways Act, and The Obstructions on Highways Removal Act, 1920.
27.	Widening the Provincial Highway, 1919.
28.	Main Road Legislation, 1919.
29.	Regulations respecting Township Roads, 1920.
30.	Township Road Legislation, as enacted by The Ontario Highways Act, 1920.
31.	Motor Vehicle Headlamps.
32.	Report of Committee on Road Accounting.
33.	The Provincial Highway Act, 1922.
34.	The Planting and Care of Roadside Trees, 1923.